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ART. II. — 1. *Botany for Young People and Common Schools. — How Plants Grow, a simple Introduction to Structural Botany. With a Popular Flora, or an Arrangement and Description of Common Plants, both Wild and Cultivated.* Illustrated by 500 Wood Engravings. By ASA GRAY, M. D., Fisher Professor of Natural History in Harvard University. New York: Ivison and Phinney. 1858.

2. *First Lessons in Botany and Vegetable Physiology, illustrated by over* 360 *Wood Engravings, from original Drawings by* ISAAC SPRAGUE. *To which is added a copious Glossary, or Dictionary of Botanical Terms.* By ASA GRAY, M. D. New York: G. P. Putnam & Co., and Ivison and Phinney. 1857.

3. *Introduction to Structural and Systematic Botany, and Vegetable Physiology, being a Fifth and revised Edition of the Botanical Text-Book.* Illustrated with over thirteen hundred Wood-cuts. By ASA GRAY, M. D. New York: Ivison and Phinney. 1858.

4. *Manual of the Botany of the Northern United States. Revised Edition, including Virginia, Kentucky, and all East of the Mississippi: arranged according to the Natural System.* By ASA GRAY, M. D. (The Mosses and Liverworts, by WILLIAM S. SULLIVANT.) With fourteen Plates, illustrating the Genera of the Cryptogamia. New York: Ivison and Phinney. 1858.

LET no tyro in science, whatever else he may attempt, undertake to write elementary books; for to simplify knowledge and make it interesting to the opening intellect requires a mind thoroughly imbued with the subject. Yet most learned men who attempt to teach the rudiments of their specialties signally fail. Doubtless they fancy, having forgotten when and how they learned first principles, that they are innate, — a part of the birthright of humanity. So they commence as if the student were already familiar with what ought to be the initial chapter, and virtually bid him read before teaching him the alphabet.

Far removed from this class is the eminent and able author

of the volumes under consideration. Beginning with the alphabet of Botany, he carries us easily and pleasantly onward, explaining every difficulty in clear, concise terms, so that one must be dull indeed who can even read attentively the "First Lessons in Botany," or the more recently published volume entitled "How Plants Grow," without obtaining a tolerable comprehension of their structure and classification, their mode of growth, and the general scope of the science. These two recent botanical works by Dr. Gray are designed for quite young persons and common schools, and are intended to enable any one to understand the nature and names of the plants that cluster around our daily paths and our homes.

What the Text-Book and Manual are to older and maturer students, "How Plants Grow," with the "Popular Flora," is to beginners; and we doubt not it is destined to become a decided favorite among all young persons. The excellence of these elementary books is what every one who has had any knowledge of Dr. Gray's previous works must have expected; for to a perfect knowledge of his subject he adds a clearness and exactness of style seldom met with, and the power of condensing in a few words a great amount of information. As an accurate analyst, he has received a just meed of praise from all foreign botanists. Standing as he does at the head of the science in our own country, and scarcely inferior to any botanist of the Old World, we consider it a subject of congratulation that he has found time, among his multifarious avocations of a high order, to write two books expressly for the young. The urgent need of a botanical primer, to introduce so charming a study into the school-room in a form attractive to children, has long been felt. The habits of observation, research, memory, and judgment, which are exercised and developed by the pursuit of natural history, are the very qualities which are most needed in every day's practical life; and if by proper educational training these discriminating powers are quickened at an early age, they will continue a constant and unfailing source of instruction and delight.

The introductory chapter presents the subject of Botany in so interesting and appropriate a light, that we cannot forbear quoting from it.

"'Consider the lilies of the field, how they grow; they toil not, neither do they spin; and yet I say unto you, That even Solomon in all his glory was not arrayed like one of these.' — Matthew vi. 28, 29.

"Our Lord's direct object in this lesson of the lilies was to convince the people of God's care for them. Now, this clothing of the earth with plants and flowers — at once so beautiful and so useful, so essential to all animal life — is one of the very ways in which He takes care of his creatures. And when Christ himself directs us to consider with attention the plants around us, — to notice how they grow, — how varied, how numerous, and how elegant they are, and with what exquisite skill they are fashioned and adorned, — we shall surely find it profitable and pleasant to learn the lessons which they teach.

"Now this considering of plants inquiringly and intelligently is the study of Botany. It is an easy study, when pursued in the right way and with diligent attention. There is no difficulty in understanding how plants grow, and are nourished by the ground, the rain, and the air; nor in learning what their parts are, and how they are adapted to each other, and to the way the plant lives. And any young person who will take some pains about it may learn to distinguish all our common plants into their kinds, and find out their names.

"Interesting as this study is to all, it must be particularly so to young people. It appeals to their natural curiosity, to their lively desire of knowing about things: it calls out and directs (i. e. educates) their powers of observation, and is adapted to sharpen and exercise, in a very pleasant way, the faculty of discrimination. To learn *how to observe* and *how to distinguish things* correctly, is the greater part of education, and is that in which people otherwise well educated are apt to be surprisingly deficient.

"Natural objects, everywhere present and endless in variety, afford the best field for practice; and the study, when young, first of Botany, and afterwards of the other Natural Sciences, as they are called, is the best training that can be in these respects. This study ought to begin even before the study of language. For to distinguish *things* scientifically (that is, carefully and accurately) is simpler than to distinguish *ideas*. And in Natural History the learner is gradually led from the observation of things, up to the study of ideas, or the relations of things.

"This book is intended to teach young people how to begin to read, with pleasure and advantage, one large and easy chapter in the open Book of Nature; namely, that in which the wisdom and goodness of the Creator are plainly written in the Vegetable Kingdom." — *How Plants Grow*, pp. 1, 2.

This may be truly called a wonderful book. The style is thoroughly scientific, and yet so clear and simple that even a little child can understand it, and become interested in the subject. It is not, like some popular works, written so far down to the comprehension of the young as to become a weak mixture, where science is diluted to the lowest possible standard, as if to keep the young mind for ever in swaddling-bands; but it is arranged and designed so to educate and expand the intellect as that a young person of ordinary capacity is soon able to seize upon, and comprehend, the principal features of the vegetable world.

The Second Part, comprising the Popular Flora, embodies, in a compendious form, an account of the most common plants, both indigenous and cultivated, of the Northern States. The ordinal characteristics, though described in few words, are so accurately determined, that he may run that reads; and nearly every family is illustrated by a drawing of one of its members, showing its peculiarities of structure and appearance, and typically representing the whole group. The common English names are given in every instance, and the beginner's mind need not be burdened with the Latin nomenclature generally regarded as a necessary appendage to the science.

When we consider that this quarto volume of two hundred and thirty-three pages, profusely and beautifully illustrated, is offered at the extremely low price of seventy-five cents, we do not hesitate to assert that it is the cheapest botanical work ever issued from the press of any country; and we congratulate Dr. Gray's publishers upon having added this admirable school-book to the excellent series already published by them. When a work like this, combining in so rare a manner the two sterling qualities of excellence and cheapness, adapted expressly to young persons, and arranged for the use of schools, emanates from the highest botanical authority, we trust a discriminating public will show a just appreciation of its merits, by discarding all the trashy volumes now in use, and adopting one which comprises in a small space the learning and research of a life devoted to the subject.

There has assuredly been found for the youth of this gen-

eration a royal road to learning, — a railroad, we may term it; for the facilities now given for climbing the hill of science may well be illustrated by the difference between a luxurious passenger-car of the present day, gliding smoothly up and down the grades which modern skill has prepared, and the slow, lumbering stage-coach of former times. Those who are now advancing in years tell us of the little assistance they received in Botany from the few and uninteresting books which could formerly be obtained here. The Linnæan system, with its artificial classification, which its author, the immortal father of Botany,* considered as but a stepping-stone to a more perfect arrangement, was then universally taught in this country. The natural system of De Jussieu had not found any exponent in the New World to popularize it for general use, and little was known or understood of structural or physiological botany. The student, wearied with the difficult nomenclature and dry labelling of the living glories of wood and field, without learning much of their affinities, anatomy or morphology, too often gave up the pursuit, or thought he had done enough, when he had gathered and arranged, by the Linnæan method, the common plants of his own locality. Now the different departments of Physiological, Systematic, Geographical, Fossil, Agricultural, and Medical Botany, open to the active inquirer an insight into the plan of the Creator in the vegetable kingdom. Some knowledge of these various branches is absolutely necessary for any one receiving a tolerable education; and surely it is a subject replete with interest to the cultivated mind. The part which vegetation performs in the physical economy is a great one, that of preparing the atmosphere for the use of air-breathing animals, and converting its mineral materials into organized matter for the food, clothing, light, warmth, and shelter of man.

* "The real merits of Linnæus as a natural systematist have never been appreciated. In the well-deserved admiration of the labors of the Jussieus, it is invariably forgotten that the effort of genius displayed by Linnæus in constructing natural genera, was as great as that of the Jussieus in classifying these into genera of a higher value, now called Natural Orders; and considering the chaotic state that both the genera and species were in upon which Linnæus worked, and the vast number of new forms he first naturally grouped into genera, the amount of labor, skill, and knowledge expended in the effort, is what can now never be fully realized." — *Hooker's Journal of Botany*, October, 1857, p. 314.

Dr. Gray's works may well be termed a grammar and dictionary to the study of Botany. Armed with these, the student, without crossing the seas, can enter a new country, for he possesses a key to the language in which the book of Nature is written; its ever-open volume is spread out before him, each page presenting some of its own features, and each chapter containing enough for the contemplation of a lifetime. There is no spot so utterly desolate that vegetation is unknown. Even amid the stone and mortar of the city, as in the prison court of Fenestrella, some *povera picciola* springs up. Mungo Park was cheered in the deserts of Africa by a little tuft of *Fissidens bryoides*, and upon the eternal snows of the polar zone, the *Protococcus nivalis* throws its roseate hue.

The fifth and enlarged edition of the Botanical Text-Book, which is now entitled "Structural and Systematic Botany and Vegetable Physiology," with its five hundred and fifty pages, and thirteen hundred fine wood-cuts, bears little resemblance to the first edition issued in 1836, which was a volume of not much more than half the size of the present, with much inferior paper and type. A comparison of the two books exhibits in a striking manner the advance in the typographic art, as applied to school and text books, during the last twenty years. Nearly the whole work has been rewritten, and carried on to the present much-advanced state of the science of Botany. The numerous illustrations of the volume are from the hand of Mr. Sprague, who has received the well-merited title of the most accurate of living botanical artists.

In proof of the consideration which the Botanical Text-Book has gained abroad, we would state that for some years it was used as the class-book in the University of Edinburgh, — a compliment seldom paid to American works, — and was superseded only when Professor Balfour of that city published his "Outlines"; a useful and elaborate treatise, but lacking the clearness and conciseness of Gray's works. Sir William Hooker, when comparing it with the "Text-Book," says: "Balfour's Outlines is far too comprehensive, and better adapted to refresh the memories of those who have mas-

tered the elements of Botany, and made some progress in its details."

The vegetable kingdom does not culminate, as the animal kingdom does, and therefore offers no foundation in nature for a lineal arrangement even of its great groups. Though botanists might arrange a connected series, beginning with the highest and descending to the lowest forms, yet this chain would not include half of the vegetable world, which may be more properly represented by a network, of which each mesh borders upon three or four others in about the same relationship. These affinities cannot be properly estimated until all the members of the group are discovered. Thus the views of botanists are liable to be modified every year, the detection of new plants, or some point of structure better understood, often changing materially the position of a group in the system. Weddell, in a recent monograph on the *Urticaceæ*, arranges that family on the faces of a three-sided pyramid, and it appears as if this plan could be adopted advantageously for a large number of orders which might thus be grouped around their representative types.

Dr. Gray's books have been so long known and so justly appreciated, both in this country and abroad, that it seems a work of supererogation to say that his Manual supplied a desideratum which had been long looked for on this side of the Atlantic, by the student and herbarist. In it are described all the known species indigenous to our Northern States, and the Artificial Key to the Natural Orders enables the student to find with ease the name and family of any plant hitherto unknown to him. The geographical limits of the present edition are much extended. The first edition, published in 1848, and hastily prepared, embraced only the Northern States, politically so called, while this includes in its area Virginia and Kentucky, stretching westward to the Mississippi River. The southern boundary of 30° 30′ was adopted, because it coincided better than any other with the natural division between the Northern and Southern Atlantic States, although a few of the characteristic Southern plants advance upon the southeastern corner of Virginia in the neighborhood of the Dismal Swamp.

The strictly Northern-temperate character of our Flora is preserved by the absence within these limits of any high mountain ranges, or considerable extent of elevated land. The White Mountains of New Hampshire, the highest elevation of which is 6,200 feet, furnish by far the greatest number of alpine species. Mount Katahdin in Maine (5,300 feet), the Green Mountains of Vermont (with a maximum elevation of 4,360 feet), the Adirondack Mountains of Northeastern New York (said to exceed 5,400 feet), and the Alleghanies (the highest points of which do not exceed 5,000 feet), are far from rich in alpine forms of vegetation, and the whole list does not equal in number that of the Southern plants which have extended into the Southeastern corner of Virginia.

Perhaps no Flora of any large region is so well known as that of the Northern United States; and although much remains to be done, it can now be profitably compared with that of Europe. We find that, of the 2,668 species Dr. Gray has here described as indigenous to the Northern States, only 676 are common to both continents. It is well known that he holds sound views in regard to the necessity of restricting the tendency which obtains among many botanists as to the multiplication of species. He considers that the authors of the principal and most esteemed European Floras would have increased the present number of our Phænogamous plants and ferns about five per cent, while another school would have added from ten to twelve per cent. His enlarged experience inclines him to take broader views of species than those which generally prevail. Our genera which have no representatives in Europe appear to be three hundred and fifty-three, or more than half of the whole number. We have twenty-six orders that are wholly unknown in Europe; and it is singular, when the lower mean temperature of our climate is considered, that these should all be of a warm-temperate or sub-tropical character, nearly all of them having their principal development in tropical regions.

These numerous orders peculiar to our country fail to overcome the European aspect of our vegetation, on account of the fewness of their species, which are the real exponents of the vegetation of any region. May not these sub-tropical

species be the vestiges of the primitive Flora, whose contemporaries and congeners are found imbedded in the coal-regions of our interior? Dr. Hooker, in his Flora of New Zealand, remarks: "Not only are those links breaking by which the botanist connects the present Flora with the past, but also those by which he binds the different members of the vegetable kingdom one to another." Daily experience teaches us that some species are more plastic than others, and adapt themselves more readily to new surroundings. Thus a few species out of these many orders may have survived immense climatic and geologic changes. When some inquiring mind discovers the clew to the geographical distribution of plants, a moot question at present among *savans*, these tropical orders of our Northern States may play a conspicuous part in the programme. We regret that Dr. Gray did not find room, in his enlarged edition of the Text-Book, for a chapter on this interesting department of botany. Although a subject so extensive could have received merely a cursory glance, yet, as it is one occupying much attention at the present day, some suggestive hints might have been thrown out.

The causes which determine the geographical distribution of plants are estimated very differently by various authors. Marine currents, heat, light, and the mechanical differences of the disintegrated rocks upon which plants flourish, have each in turn been held up as the reason why certain forms of vegetation prefer one country or spot to another. To us it appears that light, with subordinate conditions dependent on electricity and similar meteorological agencies, must exert a very important influence. The rapid growth of vegetation in high northern latitudes is now ascribed to the continued influence of light during the short summer of those regions, which by its stimulating power compresses into a few weeks the processes that occupy months in more temperate climates. All the meteorological tables of recent navigators have tended to overthrow the old notion of the intense heat of Arctic summers, and go to prove that accelerated vegetation should be attributed to the constant light to which it is exposed.

Geographic botany is attempting to solve the point so

much disputed, whether all species sprang from one common centre, and have thence been distributed over the earth; or whether there were, as some affirm, different creations on the different continents and islands to produce their diverse Floras.

> "'T is a quaint thought, and yet perchance,
> Sweet blossoms, ye have sprung
> From flowers that over Eden once
> Their pristine fragrance flung;
> That drank the dews of Paradise,
> Beneath the starlight clear,
> Or caught from Eve's dejected eyes
> The first repentant tear."

De Candolle's elaborate volumes recently published, entitled *Geographie Botanique Raisonnée*, although filled with the results of years of study devoted to the subject, appear to arrive at no decided mode of accounting for the distribution of plants. This department of botany seems still a purely speculative study. No broad principles have been laid down to serve as a common resting-place for the scattered fragments, which will doubtless one day form a glorious monument to whoever may be so successful as to find the proper corner-stone. To the traveller this study should be peculiarly recommended. An herbarium collected in an unknown land will convey to the eye of a botanist a very good idea of the climatic influences under which such vegetation flourished. Thus two plants, the *Hesperis pallasii* and the *Vesicaria arctica*, which belong to the milder regions of the Arctic zone, and had never before been detected beyond Smith's Sound, were discovered in a perfectly fruiting state on the very verge of that mysterious Polar Sea which one of Dr. Kane's party had the good fortune to behold. These plants are a collateral evidence of warmer winds or currents near the Pole, and establish the fact of some peculiar isothermal influence.

Martin's recent experiments, published in the *Comptes Rendus* of the French Academy,* prove that marine currents cannot have played so conspicuous a part in the diffusion of species as has been generally believed. He exposed for six

* August, 1857, p. 266.

weeks the seeds of ninety-eight different species of plants to the same physical conditions they would have experienced if floating on the waves of the ocean. At the end of that period forty-one were completely decayed. The remainder were sown and placed under frames, and of these only thirty-five germinated, from which number seventeen must be deducted, whose specific gravity would prevent them from floating on the surface. Martin justly considered, that six weeks was too short a time for some seeds to make a voyage from one continent to another. He therefore took duplicates of these thirty-five seeds and exposed them for three months to the action of salt-water. When planted, only seven grew; thus proving that, out of ninety-eight species left to the conjoined action of winds and waves, only one fourteenth would preserve sufficient vitality to germinate, when placed in the most favorable circumstances.

That man by his migrations effectually assists in the dispersion of species, is seen in the most troublesome weeds of our fields and pastures, which are mostly of British origin. Within a few miles' circuit of Boston may be noticed quite a number of conspicuous plants, apparently growing wild, which are well known to be only naturalized, but which, like those who brought them hither, have taken so kindly to the soil, that no one would suspect they had not held sway over it from time immemorial. Yet De Candolle expatiates upon the difficulty of naturalizing plants, and thinks that an extremely small proportion of the many thousand species which have been introduced into our gardens will eventually propagate themselves beyond those limits. Of a vast number that have been tried at the Bois de Boulogne, the *Potentilla Pennsylvanica* is the only one which is positively known to have established itself. In the neighborhood of Geneva one of M. De Candolle's friends has been in the habit, during the last eighteen years, of scattering annually hundreds of seeds collected in the botanic gardens, and hitherto without any appreciable result.

Mr. W. S. Sullivant, who elaborated the cryptogamic orders of the Musci and Hepaticæ, has in the present edition of the Manual illustrated these interesting families by eight

plates (drawn by his own hands), figuring one hundred and eighteen different genera. His well-executed drawings are a great assistance to the study of these inconspicuous but charming families. The taste for bryological research is increasing with the facilities now afforded to the student; but the necessity for the constant use of the microscope will prevent it from becoming a very popular branch of the science of botany.

By enlarging the geographical range, and embracing portions of the Southern States, Texas, and New Mexico, Mr. Sullivant has been enabled to introduce many new plants, and the nine years intervening since the last edition have been employed by bryologists in detecting species not known before to exist in this country. He has added to this edition eighteen genera of the *Acrocarpi*, and ten of the *Pleurocarpi;* but some of these are only subdivisions of long-established genera. A change has also been made in the arrangement of the genera, and that of Bruch and Schimper in the *Bryologia Europæa* has been adopted as the best authority extant. Some inconvenience might have been spared to those students who have familiarized themselves with the nomenclature of the last edition, if the old names had been inserted as synonymes; as, for instance, "Ptychomitrium incurvum; Syn. Grimmia Muhlenbergii." The specific descriptions of the *Anophytes* are in most instances too brief to enable the student who depends entirely upon this book to determine satisfactorily the name of a plant. In these obscure and microscopic orders a fuller specification of the peculiarities of each species might have been allowed, and we think every important specific character should have been mentioned. Mr. Sullivant has established the new tribe *Thelieæ*, genus *Thelia*, upon apparently good characteristic distinctions, from the section *Theliphyllum* of other authors.

In this lowest order of vegetable life, the cryptogamic plants, whose greatest height in this country does not exceed a few inches, are found the only surviving representatives of the giants of those primitive days to whom was assigned the task of rendering the earth fit for its destined guardian, man. At the dawn of terrestrial vegetation, carbonic-acid gas must have formed from three to eight per cent of the bulk of our

atmosphere, instead of less than one thousandth part, as at present. The effect of such air upon animal life is easy of demonstration. A single pound of charcoal burned converts twenty-eight cubic feet of oxygen into carbonic acid, contaminating twenty-eight hundred feet of air. Few or no terrestrial animals, except reptiles, could have existed at the epoch of which we speak. This carbonized air, with proper light and heat, was propitious to vegetation, and we therefore see the cause of its extraordinary luxuriance, and how it was made the instrument of preparing the earth for the habitation of warm-blooded animals, of which these plants were the necessary precursors.

But the greater part of the carbon thus withdrawn from the air was with far-reaching providence stored up in the bosom of the earth, in a form adapted to be of immense importance to man in after ages. In the coal-measures of the United States are found the trunks of huge tropical trees, which look like enormous bolts driven in to hold the layers of rock together. These fossil remains prove to be a very different form of vegetation from any now growing in the same region; for the insignificant Ferns and Club-Mosses which in temperate climates represent this once flourishing and magnificent family rarely exceed the thickness of a finger.

The old notion that plants give out carbonic-acid gas at night, and thus contaminate the atmosphere they purify during the day, is now exploded. Modern research has proved that the evolution of carbonic acid is not a function of vegetation, but takes place only in decaying plants. That flowers contaminate the atmosphere of a closed apartment, is an undisputed fact; but this deleterious influence is to be attributed to the poisonous and narcotic principle of the perfume acting upon the nerves. The smell of the linden-blossom often causes swooning and loss of sensation to those who chance to sleep under that tree when in flower, and the walnut and the elder are believed to produce the same effect by their shade. Linnæus records an instance in which the flowers of the Nerium proved fatal to a person sleeping in a room with them, and to most delicate nervous organizations the smell of certain flowers produces unpleasant results.

From some unexplained cause, most plants give out their odor more powerfully in darkness, and thus exert a greater effect upon the nervous system at night than during the day.

All vegetable growth is made up of minute cells, of which there may be from twenty-seven thousand to seventeen hundred and twenty-eight million in the space of a cubic inch. Centuries ago this truth, revealed only of late years, was dimly foreshadowed by the maxim, *Tota natura in minimis.* But the sages who bowed in superstitious reverence before the sacred oak, little thought the saying could be applied to the monarch of the forest, as well as to the humblest moss growing upon its weather-beaten bark. Throughout the vegetable kingdom, beginning with the simple one-celled *Oscillaria*, and going up to the modern Titan, the *Wellingtonia gigantea*, vegetation resolves itself into microscopic organic cells. The cabalistic word — the Open Sesame — destined to unlock the door of nature's laboratory, although first intimated by Grew a hundred and seventy years ago, received little attention until uttered by Robert Brown; and it was not till the microscopic researches of Mohl and Schleiden that any useful generalization was obtained. They enunciated the law that the life-story of the plant is to be studied in the cell-elements that compose it. In the words of a popular writer,

"Uttering many voices, the plants sing one grace and canticle of the same purport; the vastness and variety of the results produced by modification of the same unvarying means; the universality of cell-power, the pervading existence of cell-growth, the million developments of its resources, its shapes, its functions, its labors, and its value."

The vegetable physiologists of the present day lean decidedly toward materialism. Finding by analysis that many of the phenomena of vegetation are purely physical or chemical, they incline to account for all of them by similar agencies; forgetting that much must be referred to a higher influence, the life-giving principle of the plant, that which effects the reproduction and increase of already existing organized matter. We must confess ourselves pleased, therefore, when any *savant* brings forward this life-principle in opposition to mere physical causes. Trécul,* in recent experiments upon the

* *Comptes Rendus*, September 28, 1857.

circulation of the sap, asserts that the generally received theory of endosmose is insufficient to explain that phenomenon. The different density of the ascending and descending sap (if that explanation were the true one) would prevent the two currents from remaining distinct, but would produce instead a horizontal centrifugal current, until an equilibrium of density was established. Therefore some other cause than endosmose and exosmose must be brought forward. We are inclined to agree with Trécul, and to refer the circulation of the sap to the agency of that force known only by its effects, namely, life.

"If," says Dr. Braun, "what we call plants are nothing but complex chemical and physical *processes*, then we can no longer speak of their individuals and species in the sense the words usually bear; for the mere phenomena of the operations of the primary substance, which have no other efficient principle than the forces of this substance, cannot be regarded as self-existent beings."

To counteract this tendency of modern physiology, some German authors have attempted to believe that plants possess souls, and have absolutely asserted that "sensitive monads inhabit the secret halls of the bark palaces which we call plants." Aristotle described the internal essence of plants as a plastic soul, and when we consider their lifelike motions, as the opening and shutting of the Venus's fly-trap, the twining of vines of the same species always in one direction, the Puck-like contortions of some of the Orchis family, and their unaccountable spontaneous movements, we might readily imagine these delicate creations endowed with a sensibility akin to that of man.

Some plants, as the Horsechestnut and Magnolia, make a definite annual growth in a few days or weeks from the prepared bud of the previous year, and then form and ripen the bud for the next;—while others continue growing through the whole season; and it is on this account that the agriculturist stops their luxuriance by pinching and pruning, that they may harden the wood and provide for the following year. But the custom which so universally obtains in some cities, of cutting and lopping shade-trees, cannot be too strongly deprecated. The adventitious buds, which lie dormant, ready to fulfil the

offices of those that are injured, are thus made to grow; the beautiful symmetry of the tree — that which forms its individuality — is destroyed, and we go back to the barbarous Dutch taste without even the redeeming features of that system, which presented to the eye, if an unnatural, yet a regular form of something in heaven or earth, or the waters under the earth.

We hear the landscape gardener talk of architectural trees, as the poplar and linden, which, by their regular groupings, harmonize with the buildings near which they are planted; but our worthy friends of the Quaker City, not content with streets at right angles and houses of one pattern, would train nature into the same stiffness. With the first warm days of spring, hosts of aspirants to the topiary art peregrinate every street, and ring at every door, *demanding* leave to commence operations. For a few "levies," if the trees are young and small, or dollars, if they chance to be large and vigorous, the right to improve upon nature is bargained for, and the swelling shoots of the beautiful growth of the previous year are clipped by scissors as fatal and unsparing as those of Atropos herself. And when the luxuriant maples with which the streets are lined bear the appearance of pollarded willows, the operators and the public appear satisfied that they have performed a work worthy of all praise. The keen sarcasm of the poet Holmes is often on our tongue, as we pass these spoilers, and view with saddened eyes, lumbering the pavement, the cords of wood which were intended by a beneficent Creator to afford a grateful shadow from the noonday sun, glaring as it does with unimaginable brilliancy upon the white-marble steps and immaculate shutters of that bridal-clad city: —

> "Soon to thee
> Shall Nature yield her idle boast;
> Her vulgar fingers formed a tree,
> But thou hast trained it to a post."

The reason for the symmetrical form observed in plants of the same genus, and the great variety of shape noticed in the different families, which enables us to distinguish an oak from an elm as far as the eye can see, may be readily understood by

consulting the section in the "Lessons" devoted to Phyllotaxy, or the arrangement of the leaf on the stem. These different modes were noticed and pointed out by Bonnet as long ago as the middle of the last century, but have lately been extended and generalized by Schimper, Braun, and others.

"So the place of every leaf on every plant is fixed beforehand by unerring mathematical rule. As the stem grows on, leaf after leaf appears exactly in its predestined place, producing a perfect symmetry; — a symmetry which manifests itself, not in one single monotonous pattern for all plants, but in a definite number of forms exhibited by different species, and arithmetically expressed by the series of fractions, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$, $\frac{8}{21}$, &c., according as the formative energy in its spiral course up the developing stem lays down at corresponding intervals 2, 3, 5, 8, 13, or 21 ranks of alternate leaves." — *First Lessons in Botany*, p. 75.

A paper lately read before the Botanical Society of Edinburgh showed that an analogy exists between the serial arrangement of leaves and crystalline forms. A singular fact has been recently discovered by Professor Peirce of Cambridge, which goes to prove the unity of the laws that guide the whole physical universe. The mathematical rule noticed in the spiral arrangement of the leaves of plants, in which the numerator and denominator of each term equal severally the sum of the numerators and the denominators of the two terms next preceding, is identical with the law which governs the revolutions of the solar system and "holds the planets in their course." Agassiz, in his Contributions to the Natural History of the United States,* gives tables of the revolutions of the different planets, and their relative ratio, and proves that they correspond with the normal series of fractions expressing the law of phyllotaxis, as given by Dr. Gray in the paragraph above cited. So we perceive that, however humble the plant, every individual of the species has its leaves arranged around the central axis, the stem, at the same angular divergence, following a fundamental and immutable law, which is also applied to the planets of the solar system, sweeping through infinite space around their centre, the sun, —

* Page 128.

"And the poet, faithful and far-seeing,
Sees alike in stars and flowers a part
Of the selfsame universal being."

The petals are so analogous to the leaves of the branch, that in common language they are called the leaves of the flower. We may regard a flower as a transformed branch; for the arrangement of the leaves also governs the whole arrangement of the blossoms. This doctrine of vegetable metamorphosis was first suggested by Linnæus, but was so obscurely enounced that it failed to attract attention.

"This subject is to botany," says Dr. Gray, in the Preface to the first edition of his Elements, "what the theory of the atomic constitution of bodies is to chemistry; its principles, as triumphantly established by Du Petit-Thouars, Brown, and De Candolle, having given a new aspect to the science, and rendered it perhaps the most logical of all the departments of natural history."

About twenty years after this suggestion had been propounded by Linnæus,* Wolff taught the same theory; and the really scientific treatise of the poet Goethe was written twenty years later still. But none of these writings appears to have exercised any influence over the progress of the science, until it had reached a certain stage early in the present century, when De Candolle, ignorant of what others had suggested on the subject, developed from an original point of view the idea of a symmetry in the flower, which, modified by suppressions, alterations, and irregularities, gives rise to the endless variety of forms which we are never tired of observing. By this metamorphosis of plants the botanist does not intend to imply the actual change of existing leaves into flowers, but that they are all homologous parts, although developed in different shapes that they may serve diverse offices in the vegetable economy. One can easily discern that the sepals are modified leaves, and the petals only refined sepals. Stamens are often changed to petals, as in the water-lily; and there are instances of pistils taking the place of

* "Principium florum et foliorum idem est. Principium gemmarum et foliorum idem est. Gemma constat foliorum rudimentis. Perianthium sic ex connatis foliorum rudimentis," etc. — *Philosophia Botanica*, p. 301.

stamens, as noticed in the two apple-trees in Ashburnham, Massachusetts, mentioned by Dr. Gray. The gardener takes advantage of this natural tendency to produce double flowers; the stamens and pistils give place to petals, which may often be observed in the transition state, still bearing a distorted lamina on one side and a half-formed anther on the other; but the whole economy of the flower is diverted in this case from its proper purpose, the production of seed, to form the full rosette of petals which we admire in the Dahlias, Camellias, and Anemones of the garden.

The theory of development, which made so much noise after the publication of "Vestiges of the Natural History of Creation" by a learned physicist of Oxford, now finds little favor, as it was ably controverted at the time by scientific men, and much ridicule was thrown upon the idea that the Infusoria could ever become quadrupeds, or aspiring oysters, men. Yet we occasionally meet supporters of the doctrine, who, driven from their strong-hold in the animal kingdom by the revelations of the microscope, still fancy some proof of the theory to linger in the vegetable world; as if the law once issued from heaven, "Let the earth bring forth grass, the herb yielding seed, and the fruit-tree yielding fruit after his kind, whose seed is in itself," could be revoked and annulled.

"The difference between the views of those who advocate the theory of the creation of species by development or transmutation," says Sir William Hooker, "and those who believe in a special creation, is very wide indeed. That species do run into varieties, and that some of them may have originated in an altered state of some pre-existing forms, is perfectly intelligible, and admitted by all botanists, as well as by the Progressionists; but for any such species so to change as to assume all the characters of another, within the limits of our experience, is for Nature to break one of her immutable laws. *Natura nihil facit per saltus.*"

The Progressionists hold up the well-known fact that a growth of pine succeeds hard wood, not perceiving that this is nature's order of the rotation of crops; and that after the elements of the soil which enter into the composition of deciduous trees are exhausted, and they are cut down or burned,

there still remain in the arid earth the materials upon which the Coniferæ will flourish, whose seeds, long buried in the soil, are quickened by the sun's rays, spring up, and grow, smothering the half-starved oaks which may chance to germinate.

Mr. Vaupell, a Danish gentleman who has recently been examining the fossil forests of Denmark, does not believe in the natural succession of races, although he is forced to acknowledge that this change occurs. The remains of wood found in the turf-bogs of Denmark consist of the pine, birch, and oak; whereas the present forests of that country are almost entirely composed of beech. This tree, he thinks, has usurped the place of other species, because the soil has become drier, and therefore better fitted for its growth; and when once it obtains foothold, its heavy foliage effectually keeps down other families.

It is doubtless true, as Mr. Vaupell asserts, that wood allowed to fall and decay restores to the earth all the nutriment it has withdrawn from it, and the ground is therefore able to nourish the same species again. We can notice this fact in our own forests, where the mouldering and moss-grown trunks of fallen trees are overshadowed by their green and vigorous descendants. But this is not the case when wood is cut down. The nourishment is withdrawn from the soil, and we observe a change in the race of trees adapted to the change in the chemical properties of the ground in which they flourish.

Seeds protected from those agents which facilitate vegetation may be preserved for a great length of time; although we are not inclined to credit the stories of wheat raised from the grain with which Joseph filled the storehouses of Egypt. Yet there are well-attested instances in which the vitality of seeds has been preserved for several hundred years. A raspberry-seed, which must have ripened in the time of the Emperor Hadrian, was taken from the stomach of a skeleton, found thirty feet below the surface of the earth, in one of the Roman barrows of England; it grew and produced fruit. Peas from Tournefort's herbarium germinated after having lain there a hundred years. A bag of Mimosa-seed, gathered

seventy years ago, still supplies the Jardin des Plantes with sensitive plants, and species for many years lost to florists occasionally spring up on the site of old botanic gardens. In view of these well-attested facts, the researches of learned men and the discoveries of modern science afford no foothold for the idea of the change of species, and we may re-echo in a scientific form the ethical question of our Saviour, still sure of a negative answer, — "Do men gather grapes of thorns, or figs of thistles?"

That botany is a useful study, no one will now venture to deny. A writer in a recent number of a medical review,* while urging upon medical schools greater attention to this hitherto much neglected science, has the following judicious remarks: —

"With a wide and almost unknown territory full of vegetation springing up around us, and unknown and unexamined herbs amid our forests, and with the ancient remedies of our forefathers lost or of no avail, it is our duty to examine, and to go on examining, experimenting, heaping up facts, with faith, patience, and perseverance, until we have gained a knowledge of all. We have heard of a theory that no disease exists in a country without an antidote springing up from the soil, and Scotch boys tell us 'no stinging nettle grows without a dockin leaf close by,' and we believe there is much truth in the statement."

The American Medical Association strongly recommends that a more extended knowledge of botany be furthered among its members; and we trust the time is not far distant when every school and college in our country will perceive the necessity of a thorough education in this important branch of knowledge. It is to the rising generation, the children who will be taught from the excellent elementary books here recommended, that we are to look for the future advancement of the science.

In his capacity of teacher of college classes, Professor Gray finds but a small number out of the many young men who come under his instruction who evince any decided taste for botanical pursuits. This defect must be attributed to the fault of early education. We doubt not that all children, if

* The North American Medico-chirurgical Review, for January, 1858.

properly taught, would possess a certain appreciation of the wonders, and an interest in the beauties, of the vegetable world. The love of flowers seems inherent in childhood; their bright colors and beautiful variety attract the eye at a tender age, and if, in exercising the memory and training the intellect, Botany can gain a stand-point upon the platform now universally conceded to the Latin Grammar and Mathematics, much will be accomplished. Not that we would depreciate the advantages arising from the study of the dead languages, particularly the Latin, which is so necessary in the science under consideration; but how many there are who have a decided dislike for those studies, and whose leisure hours are a waste and a weariness to themselves and their friends, yet who might have become proficients in botany had their attention been early attracted, and their minds trained, by the study of this most charming and instructive of the natural sciences! A taste would thus be formed which can never fail. Other earthly pleasures may pall, but the true botanist is everywhere at home and among familiar friends. The lone mountain and the dark forest are, to his instructed vision, peopled with living forms, among which he can never feel desolate. He can call them all by name. He knows their family relations, and little anecdotes of their history. He can tell in what distant parts of the earth their cousins dwell, and what remote branches of their households have become extinct, and are for ever embalmed in the coal-beds of the world, — a more magnificent and secure mausoleum than those in which the glory of the Pharaohs was enshrined. Perchance the names of the plants flourishing around him recall the image of some cherished friend or master in the science, who though dead still speaks from an ever-blooming and self-repairing monument, which the showers of every May deck anew to his memory, while the shrill autumnal winds scatter only for a season the imperishable memorial of his life and labors.

The Address has for its aim to determine the order in which the young mind should have the different objects of knowledge and subjects of study presented, in order to the symmetrical development of its powers, and the thorough comprehension of what it professes to know. In "the hierarchy of sciences" the author recognizes five divisions, Theology, Psychology, History (including language, and all that appertains to human development), Natural History (including chemistry and mechanics), and Mathematics. In mathematics we depend on intuitive perception for facts and laws, on observation for their embodiment in space and number; in theology we rest ultimately on the interior consciousness; while natural history bears close kindred to mathematics, and psychology to theology. As the perceptive faculties are first matured, while the reflective powers and the introspective faculties are of later growth, education should follow, in the main, the inverse order of the hierarchy. Religious instruction indeed should not be wanting to the very earliest years, and, as the powers are developed simultaneously, though with different degrees of rapidity, neither of the sciences should be wholly excluded from any stage of education; but the order in which the powers attain maturity should govern the stress to be laid upon each in educational processes. In the course of the discussion, the prime importance of natural history, as a prominent branch of instruction, and its fitting precedence, in the order of time, of the "historical" study of language, is illustrated with equal justice and power. We regret that we have not space to follow out the reasoning of this admirable discourse, which, with this brief sketch, we earnestly recommend to the careful study of our readers.

ERRATA.

Page 327, line 5 from bottom, *for* 30° 30′, *read* 36° 30′.

In Art. II., the reference to an Oxford Professor, as the probable author of the "Vestiges of the Natural History of Creation," is believed to be erroneous.

Page 494, the sentence commencing at the fifth line should read as follows: — "They form the substratum of the population of historical Greece, on both sides of the Ægean, — 'the dark background of its history.'"

Page 505, line 13, *for* "state," *read* "states."